High Average Power Table-Top Soft X-Ray Lasers Using Diode-Pumped Laser Drivers

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Abstract: *We discuss advances in the development of high repetition rate, high average power, table-top soft x-ray lasers operating at sub-20 nm wavelengths. We report the first operation of a table-top soft x-ray lasers at repetition rates up to 400 Hz*

Soft x-ray lasers (SXRLs) produce the highest energy pulses of coherent ultrashort wavelength radiation. Their large number of photons per pulse allows us to perform single shot imaging of nano-scale objects, to develop material composition sensitive nanoprobes, and to conduct interferometric diagnostics of bright dense plasmas. However, until recently, with the exception of capillary discharge lasers at 46.9 nm, their average power was been limited by the low repetition rate of the high energy optical pump lasers required to drive them and by the relatively low pumping efficiency. We have developed a diode-pumped, picosecond Yb:YAG CPA laser driver that allowed us to demonstrate the first table-top SXRL capable of 100 Hz repetition rate gain saturate operation. These new pump lasers combined with efficient plasma heating techniques enable the operation of SXRLs at four orders of magnitude higher repetition rate than the first plasma-based collisional SXRLs (Fig. 1). Laser operation at 100 Hz repetition rate generated an average power 0.2 mW at 18.9 nm (Ni-like Mo) , and an average power of 0.1 mW at $\lambda = 13.9$ nm (Ni-like Ag) [1]. We will discuss results of an initial demonstration of a compact table-top soft x-ray laser at a repetition rates up to 400 Hz.

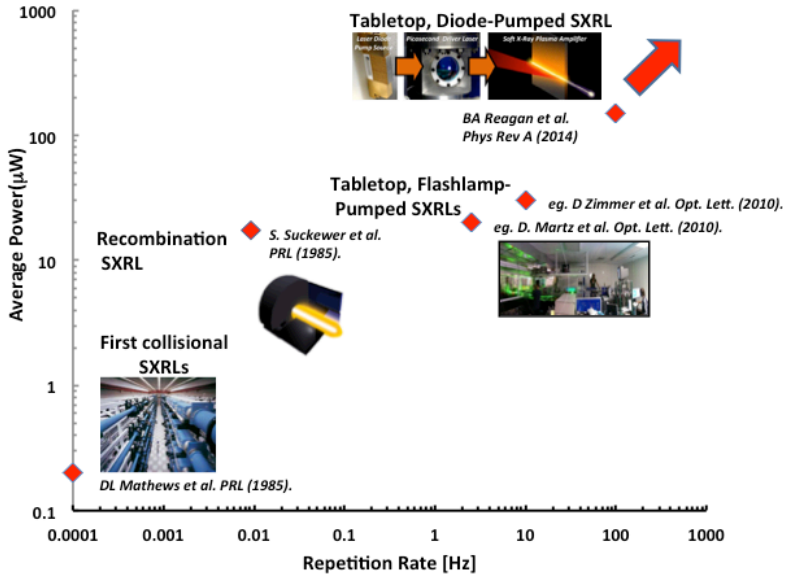

Fig. 1. Progress in the development of high repetition rate plasma-based soft x-ray lasers. plasma-based soft x-ray lasers have increased in average power and repetition rate by more than four orders of magnitude. Diode-pumped optical laser drivers now allow compact soft x-ray lasers to operate up to 400 Hz repetition rate (not shown in the plot]

Work was supported by the U.S. Department of Energy, Office of Science, and by the National Science Foundation .

1. B. A. Reagan, M. Berrill, K. Wernsing, C. Baumgarten, M. Woolston, J. J. Rocca, "High-average-power, 100-Hz-repetition-rate, tabletop soft-x-ray lasers at sub-15-nm wavelengths," Physical . Review. A. **89**, 53820, 2014.